United States General Accounting Office

GAO

Report to the Chairman, Subcommittee on Science, Technology, and Space, Committee on Commerce, Science, and Transportation, U.S. Senate

December 1988

SPACE SHUTTLE

Readiness of the Transoceanic Abort Landing Sites

GAO

United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

B-227537

December 16, 1988

The Honorable Donald W. Riegle, Jr.
Chairman, Subcommittee on Science,
Technology, and Space
Committee on Commerce, Science, and
Transportation
United States Senate

Dear Mr. Chairman:

This report responds to your request that we assess the operational readiness of the National Aeronautics and Space Administration's (NASA) Transoceanic Abort Landing (TAL) sites to support space shuttle missions. On July 28 and August 11, 1988, we provided your representatives with information on the results of our work. This report summarizes and updates that information.

There are several landing options for the space shuttle in the event of a contingency. NASA defines a contingency as "...an operational event requiring termination of a prelaunch, flight, or landing operation, which results in substantial damage to the orbiter and/or injury to personnel or has the potential to do so." A contingency could occur during the launch because of a performance problem, such as a main engine malfunction, or a system failure, such as a large cabin leak. Among the landing options are TAL sites equipped with navigational and landing aids, communications systems, and personnel to support an emergency shuttle landing. Use of TAL sites are viable options during approximately the first 2-1/2 to 8-1/2 minutes of the launch. The four current TAL sites are at Ben Guerir, Morocco; Moron Air Base, Spain; Zaragoza Air Base, Spain; and Banjul, The Gambia. For support of shuttle missions before the Challenger accident, Zaragoza, Moron, and Dakar, Senegal, were the designated TAL sites. In addition, Casablanca, Morocco, was set up temporarily to support Challenger's last mission. After the Challenger accident, Dakar was replaced by Ben Guerir, and Banjul was added.

TAL site readiness is a critical item in the launch criteria for each shuttle flight. Readiness includes preparing and equipping the TAL sites and arranging for support personnel and security, medical, and crash, fire, and rescue services. Our discussions with agency officials, examinations of pertinent documentation, and visits to the TAL sites indicated that the TAL sites would be ready to support the resumption of space shuttle missions. An Operational Readiness Inspection was completed in July 1988

for each TAL site prepared for the September 29, 1988, shuttle mission (STS-26). This was a detailed inspection of all factors that relate to the activation and overall readiness of the TAL sites. It included an inspection of items such as the installation of equipment in accordance with specifications; the availability of trained personnel; crash, fire, and rescue plans and procedures; the readiness of fire fighting vehicles; and security arrangements.

The inspections identified some TAL site activities that were not fully satisfactory, including two items of major importance—security arrangements at Ben Guerir and the installation of an arresting barrier at Banjul. Regarding the security issue, the government of Morocco and NASA had not agreed to the cost and level of security services at Ben Guerir. NASA subsequently negotiated an interim agreement that provided 33 Moroccan security personnel to cover the launch of the STS-26 mission. The Moroccan government accepted NASA's proposal, but provided approximately 135 additional security personnel for the STS-26 mission. NASA anticipates that the Moroccan government will require it to fund only the 33 security personnel agreed upon in the negotiations. NASA renewed its efforts to negotiate a long-term agreement for future shuttle launches in early November 1988, and the cost of the Moroccan security personnel provided for the STS-26 mission is part of the negotiations.

Although final security arrangements at Ben Guerir were still pending at the time of the STS-26 launch, NASA completed the installation of the arresting barrier at Banjul. There were no other unresolved items.

More detailed information on the results of our work is presented in the appendixes. Our objective, scope, and methodology are discussed in appendix I. As requested, we did not obtain official agency comments.

Unless you publicly announce its contents earlier, we plan no further distribution of the report until 10 days after its issue date. At that time we will send copies to the Chairmen, House and Senate Committees on

Appropriations and House Committee on Science, Space, and Technology; the Administrator, NASA; and other interested parties.

Sincerely yours,

Harry R. Finley

Harry R. Finley
Senior Associate Director

Contents

Abbreviations

DOD	Department of Defense
KSC	Kennedy Space Center
NASA	National Aeronautics and Space Administration
PAPI	Precision Approach Path Indicator
RMAF	Royal Moroccan Air Force
TAL	Transoceanic Abort Landing

Introduction

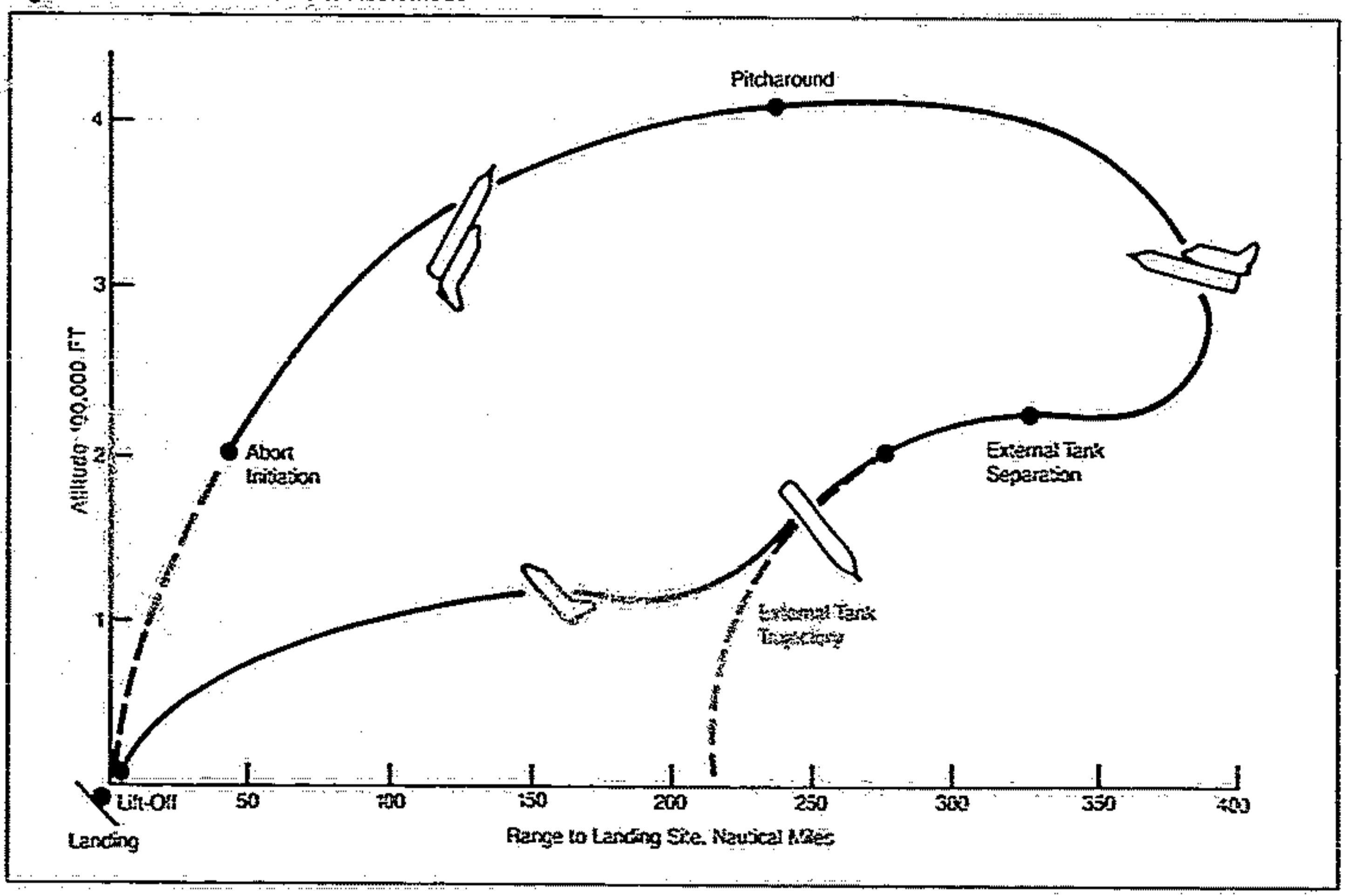
As part of its space shuttle mission support activities, the National Aeronautics and Space Administration (NASA) has designated transoceanic and emergency landing sites in the event of a contingency. NASA defines a contingency as "...an operational event requiring termination of a prelaunch, flight, or landing operation, which results in substantial damage to the orbiter and/or injury to personnel or has the potential to do so."

NASA specifies two conditions under which a contingency could occur during the launch operations—a performance problem, such as a main engine malfunction, or a system failure that precludes orbiting operations, such as a large cabin leak. These conditions would require an immediate landing, and NASA has provided a variety of landing options for the shuttle. The time span for selecting these options overlap, and it is possible to execute one of them anytime from shortly after solid rocket booster separation until main engine cutoff.

Return to Launch Site

Under the Return to Launch Site option, the shuttle would turn around, jettison its external tank, and land at Kennedy Space Center (KSC) (see fig. I.1). A NASA official stated that this option is not the preferred choice because it would involve turning the space shuttle around using an undemonstrated maneuver. This option takes approximately 22 minutes from launch to landing. If this option were selected, it would occur in approximately the first 2-1/2 to 4 minutes of the launch.

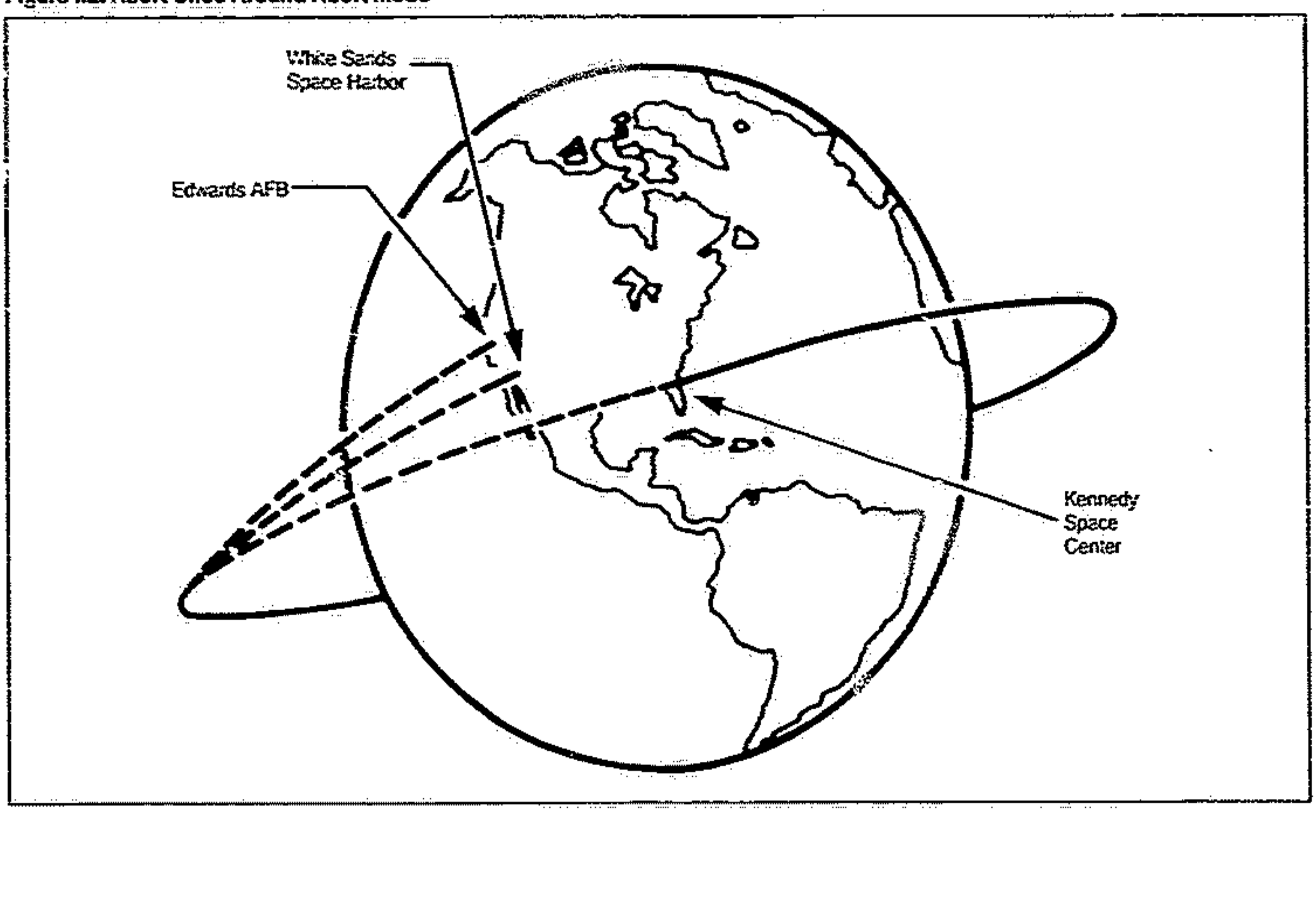
Figure I.1: Return to Launch Site Abort Mode



Abort Once Around

Under the Abort Once Around option, the shuttle would circle the earth once and land at one of the end-of-mission landing sites (those landing locations equipped to support normal end-of-mission landings): Edwards Air Force Base, California; White Sands Space Harbor, New Mexico; and KSC, Florida (see fig. I.2). This option may be executed if the orbiter does not have enough energy to attain orbit but can maintain a suborbital flight path. It takes about 1-3/4 hour from launch to landing. If this option were selected, it would occur in about the first 5 to 9 minutes of the launch.

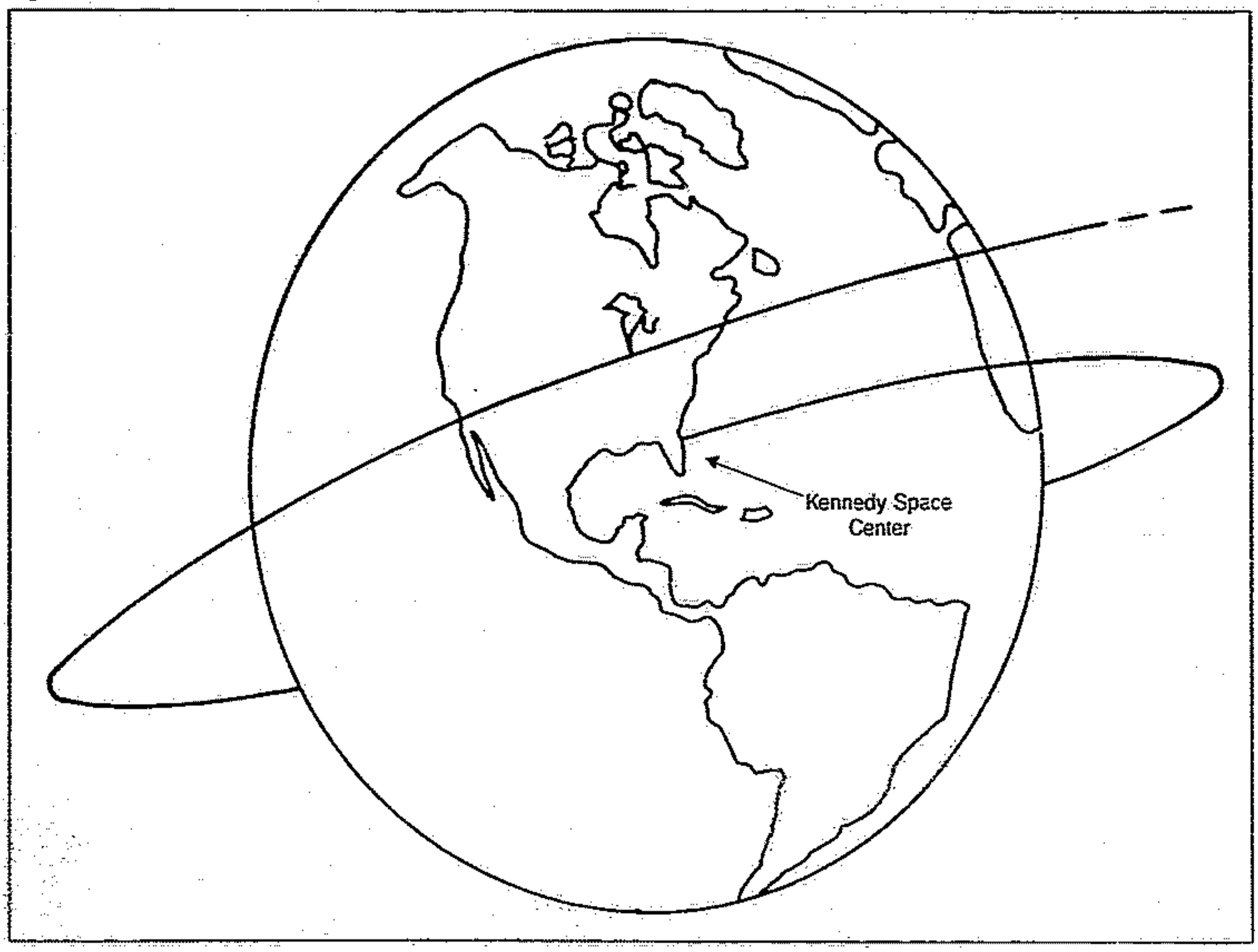
Figure I.2: Abort Once Around Abort Mode



Abort to Orbit

Under the Abort to Orbit option, the shuttle would fly to a lower-than-planned orbit, depending on the amount of fuel available (see fig. I.3). NASA officials stated that this option is viable only if the shuttle could make three complete orbits of the earth. This maneuver allows NASA time to evaluate problems and decide whether to return the shuttle to earth or use its maneuvering system to raise the orbit and continue the mission. This option, like the Abort Once Around option, could be selected in about the first 5 to 9 minutes of the launch.

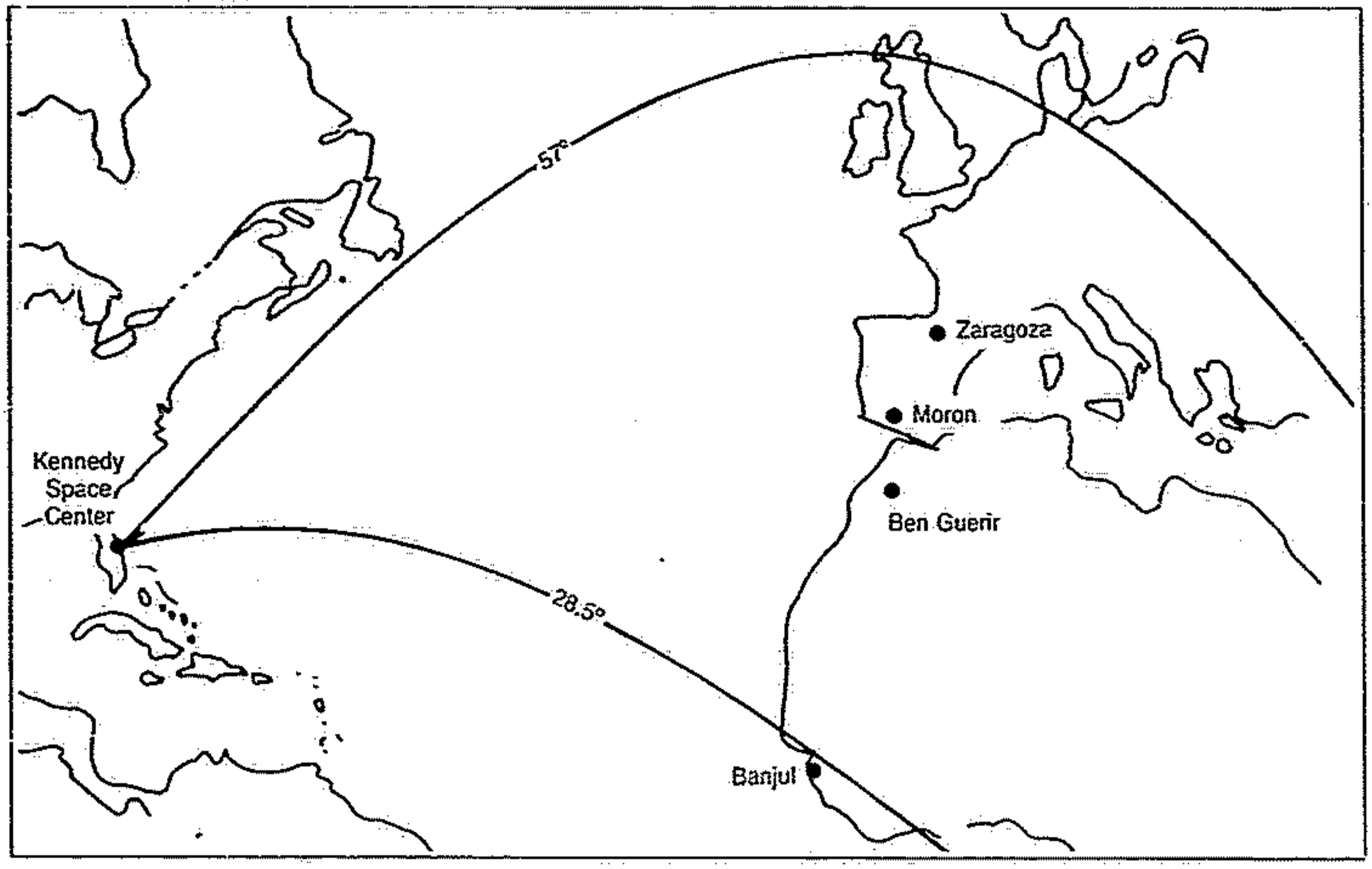
Figure I.3: Abort to Orbit Abort Mode



Transoceanic Abort Landing Sites

If a Return to Launch Site Abort is not selected and the shuttle cannot execute an Abort Once Around or an Abort to Orbit, it can land at a Transoceanic Abort Landing (TAL) site. TAL sites are predetermined landing locations equipped with navigational and landing aids and personnel to support an emergency shuttle landing. TAL sites are viable abort options during approximately the first 2-1/2 to 8-1/2 minutes of the launch. Figure I.4 shows the four TAL sites: Ben Guerir, Morocco; Moron Air Base, Spain; Zaragoza Air Base, Spain; and Banjul, The Gambia.

Figure I.4: TAL Site Abort Mode



Ben Guerir, Morocco

Base Aerienne, Ben Guerir, Morocco, will be the primary TAL site for 28.5-degree launches and an alternate TAL site for 57-degree launches.[1] Ben Guerir was formerly a U.S. Air Force Strategic Air Command Base, which was abandoned in 1962. It is located in a vast, flat desert region about 36 miles north of Marrakech, Morocco.

Moron Air Base, Spain

Moron Air Base is an operating Spanish base located in southern Spain, about 35 miles southeast of Sevilla. The U.S. Air Force maintains a detachment at Moron to help maintain base structures, systems, and utilities. Moron is an alternate TAL site on both high- and low-inclination launches. The weather at Moron is generally good, with ceiling and visibility greater than 10,000 feet and 3 miles, respectively, approximately 80 percent of the time.

Zaragoza Air Base, Spain

Zaragoza Air Base is an operating Spanish Air Force base with an active U.S. Air Force tactical fighter wing. Zaragoza is the primary TAL site for high-inclination launches.

Banjul, The Gambia

Banjul International Airport is referred to as a contingency in-plane TAL site. For the space shuttle to land at one of the other TAL sites, it must have sufficient energy to change its trajectory. If it does not have this capability—for example, if two of its three main engines fail—it can land at Banjul because the airport lies directly beneath the flight path of 28.5-degree launches.

Emergency Landing Sites

Other landing locations have been designated by NASA as emergency landing sites. These sites could be used for emergency landings if none of the previously discussed abort options are feasible. Unlike TAL sites, which have shuttle-specific navigational equipment, landing aids, and predeployed NASA, Department of Defense (DOD), and contractor personnel to support shuttle landings, an emergency landing site has no specialized equipment and is not required to maintain any specific alert posture. Emergency landing sites are selected on a mission-by-mission basis and have an extremely low probability of use. Personnel at DOD emergency landing sites have received training in emergency landing

[1] Two inclinations are used to launch the shuttle depending on the designed orbit location of the shuttle's payload—28.5 degrees or 57 degrees. The low-inclination launches (28.5 degrees) are the most frequently employed, whereas high-inclination launches (57 degrees) are used primarily for DOD payloads.

procedures, whereas personnel at other emergency landing sites are not being given any training. Some of the more than 30 emergency landing sites are listed below.

Examples of Emergency Landing Sites

Anderson Air Force Base, Guam (DOD)[2]
Brize Norton, United Kingdom
Darwin, Australia
Diego Garcia, Chagos Archipelago (DOD)[2]
Diyarbakir, Turkey
Hao, French Polynesia
Hoedspruit, South Africa
Amilcar Cabral, Cape Verde
Kinshasha, Zaire
Las Palmas, Grand Canary Islands
NAS Souda Bay, Crete (DOD)[2]

Objective, Scope, and Methodology

The Subcommittee on Science, Technology, and Space, Senate Committee on Commerce, Science, and Transportation, asked us to review the readiness of the TAL sites to support space shuttle mission launches.

We developed the information in this report through examinations of technical and budget documents and discussions with NASA officials at NASA Headquarters, Washington, D.C.; KSC; and the TAL sites. We visited the TAL sites and observed equipment stored at the sites, equipment-related construction, and other preparation activities. In addition, we met with DOD officials in Moron and Zaragoza, Spain; U.S. Embassy officials in Spain, Morocco, and The Gambia; and representatives of the Royal Moroccan Air Force, the U.S. Information Service, the Moroccan U.S. Liaison Office, and the U.S. Navy Office in Charge of Construction, Mediterranean.

We discussed the contents of this report with TAL program officials and considered their comments. As requested, we did not obtain official agency comments. We performed our work from April to August 1988 in accordance with generally accepted government auditing standards.

[2] Personnel at these sites have received some rescue training.

TAL Site Readiness

A critical item in the launch criteria for each shuttle flight is the readiness of those TAL sites selected to support the flight. Readiness includes preparing and equipping the TAL sites and arranging for support personnel and security, medical, and crash, fire, and rescue services.

In addition to specific mission readiness, each TAL site receives an Operational Readiness Inspection, jointly conducted by NASA, NASA contractors, and DOD. This is a one-time detailed inspection of the documentation addressing all factors that relate to the activation and overall readiness of the TAL sites, which verifies the readiness of a TAL site to support space shuttle missions. It includes an inspection of about 20 items, such as the installation of equipment in accordance with specifications; the availability of trained personnel; crash, fire, and rescue plans and procedures; the readiness of fire fighting equipment; and security arrangements.

Operational Readiness Inspections for each TAL site activated for the STS-26 launch were conducted and completed in July 1988, after our field work.[3] These inspections identified some items that were not fully satisfactory, including two items of major importance—security arrangements at Ben Guerir and the installation of an arresting barrier at Banjul.[4] The security issue at Ben Guerir was not fully resolved at the time of the STS-26 mission, but NASA negotiated an interim agreement with the Moroccan government that covered that mission. This issue is discussed in more detail in appendix III. NASA completed the installation of the arresting barrier at Banjul before the STS-26 launch. There were no other unresolved items.

The results of the Operational Readiness Inspections, as well as our discussions with agency officials, examinations of pertinent documentation, and visits to the TAL sites, indicated that the TAL sites would be ready to support space shuttle missions.

[3] Ben Guerir, Moron, and Banjul were activated for the low-inclination STS-26 launch. The Operational Readiness Inspection for Zaragoza—the primary TAL for high-inclination launches—was done on November 4, 1988.

[4] Anything left to be accomplished after an Operational Readiness Inspection is treated as an open item, and NASA tracks them until they are closed out or waived. KSC officials have a weekly teleconference with officials at Johnson Space Center, other NASA organizations responsible for open items, and the DOD Manager for Space Transportation System Contingency Support Operations (see p. 25) to review the latest activation status and discuss the progress being made on open items.

Site Activation

Site activation involves installing navigational equipment, landing aids, and communications equipment at the TAL sites. Once installed, the equipment is tested for accuracy and reliability. Some equipment requires the construction of special concrete foundations. NASA plans to leave some equipment in place permanently, whereas other equipment will be temporarily installed for use during the launch of each shuttle mission. This equipment will be placed in storage facilities between launches.

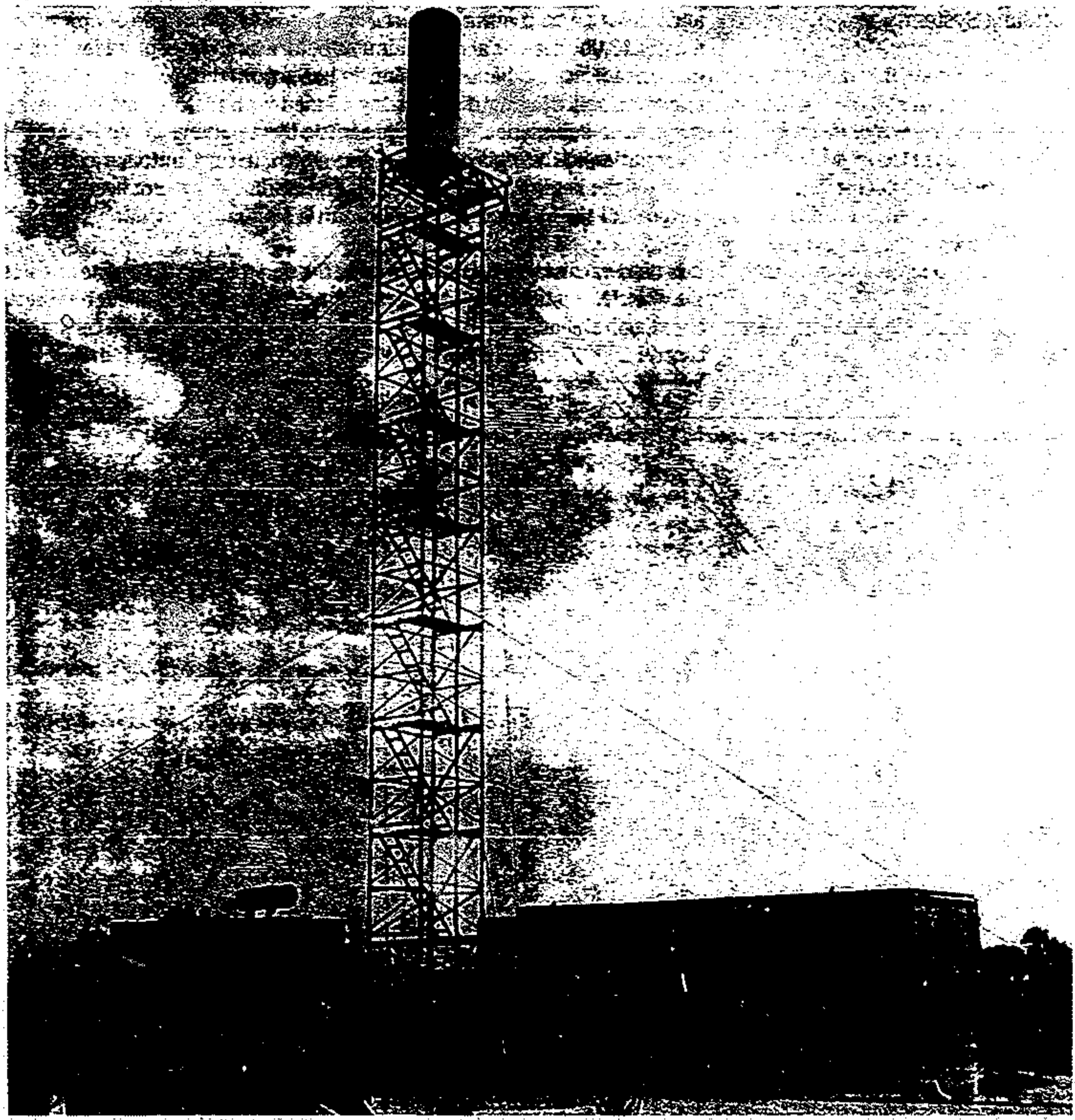
Navigational Equipment

NASA employs two principal navigational systems at each of the TAL sites—the Tactical Air Navigation System and the Microwave Scanning Beam Landing System. These two systems had been installed at each of the TAL sites at the time of our visits.

Tactical Air Navigation System

This system updates the shuttle's on-board navigational equipment when it is about 200 miles away and provides precise guidance information to align the shuttle with the runway. It is installed permanently and can be used by airports and air bases for other air traffic using the facility. Figure II.1 shows a typical Tactical Air Navigation System facility.

Figure II.1: Tactical Air Navigation System Facility



Microwave Scanning Beam Landing System

This system is used for final guidance on approach to the landing site and makes contact with the shuttle when it is at an altitude of approximately 13,000 feet, or about 2 minutes before landing. It provides information indicating whether the shuttle has acquired the correct angle of approach and whether it is properly aligned with the runway. If necessary, it can automatically land the shuttle by supplying the necessary information to the on-board computer, which, in turn, automatically controls the landing. However, automatic landings have not been flight tested, and the astronauts land the shuttle manually.

It is used exclusively by the space shuttle, and NASA installed one at each TAL site. The installation included pouring concrete pads for each system and digging trenches to run power cables from the system to a central control unit. Figure II.2 shows a Microwave Scanning Beam Landing System facility.

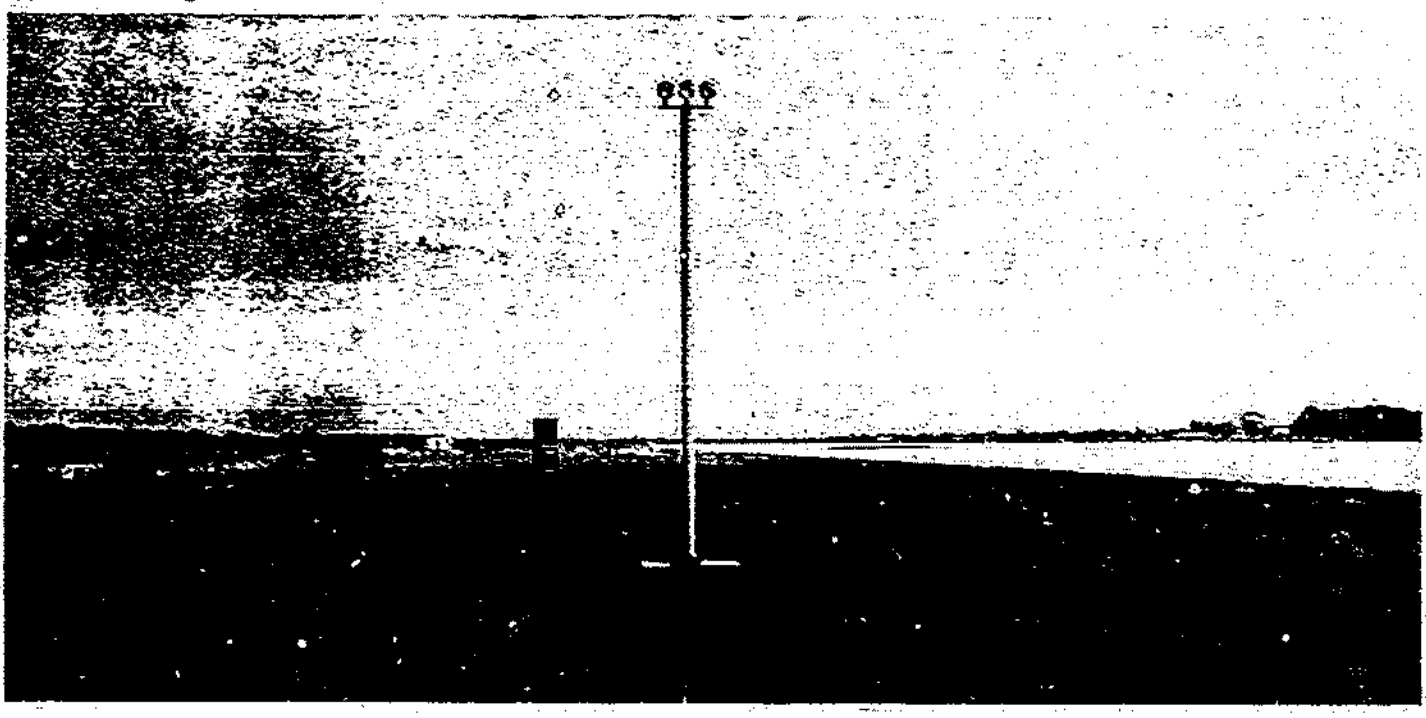
Figure II.2: Microwave Scanning Beam Landing System Facility

Landing Aids

Shuttle pilots would also use other aids on final approach and landing at a TAL site, including the following.

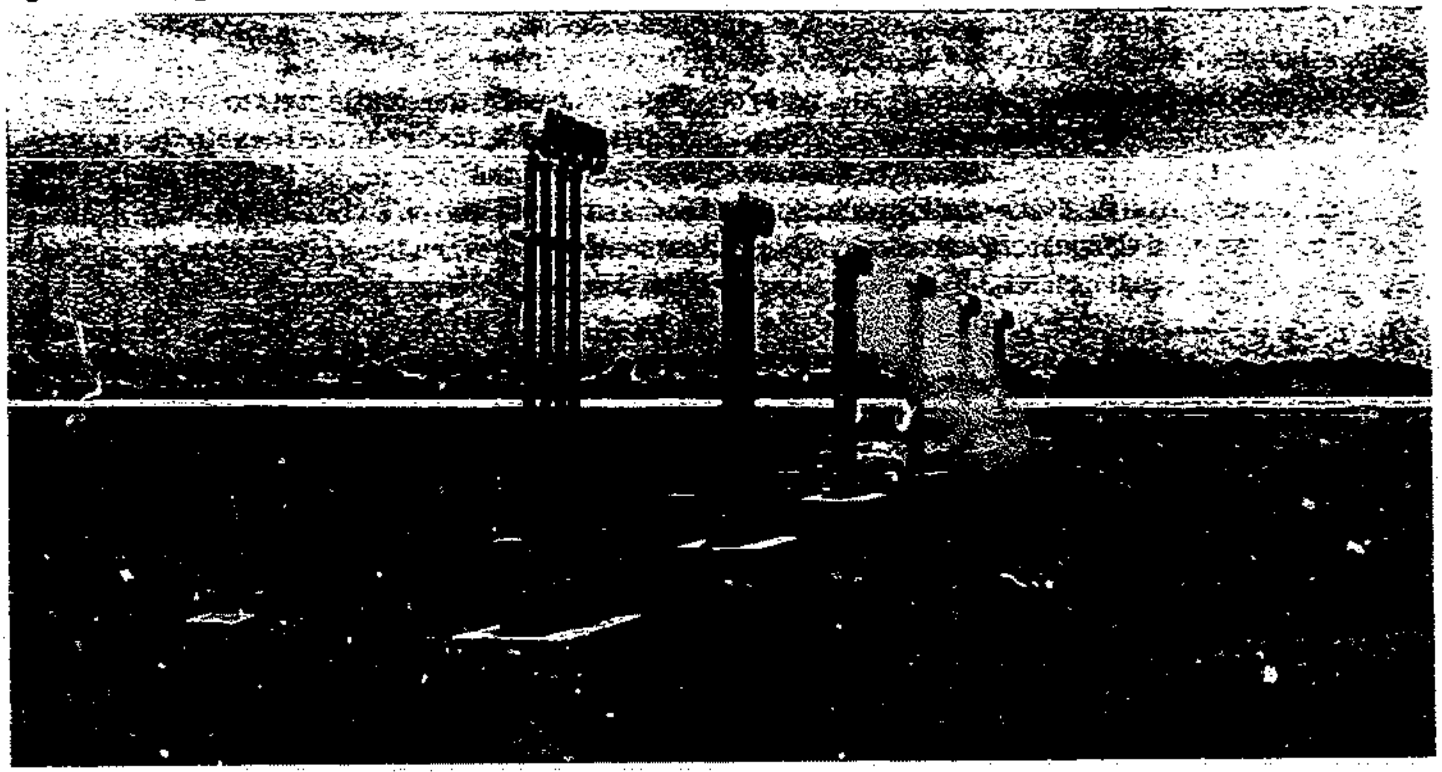
- Ball and bar lights would be used by the shuttle crew to verify proper inner glideslope[5] for landing. Ball lights are located next to the runway and consist of a row of red lights that are parallel to the ground (see fig. II.3). A bar light is a white light located on a vertical pole some distance behind the ball lights (see fig. II.4). When the white light is superimposed on the red lights, the pilot is able to determine the proper glideslope of 1-1/2 degrees. The ball and bar lights are installed before each launch. After the launch, the lights are dismantled and stored until the next scheduled launch.

Figure II.3: Ball Lights



[5]Glideslope (see fig. II.5) determines the position and descent rate as the shuttle approaches the runway. When on the proper inner glideslope, the shuttle will be at the correct position and descent rate to accomplish a satisfactory landing.

Figure II.4: Bar Lights

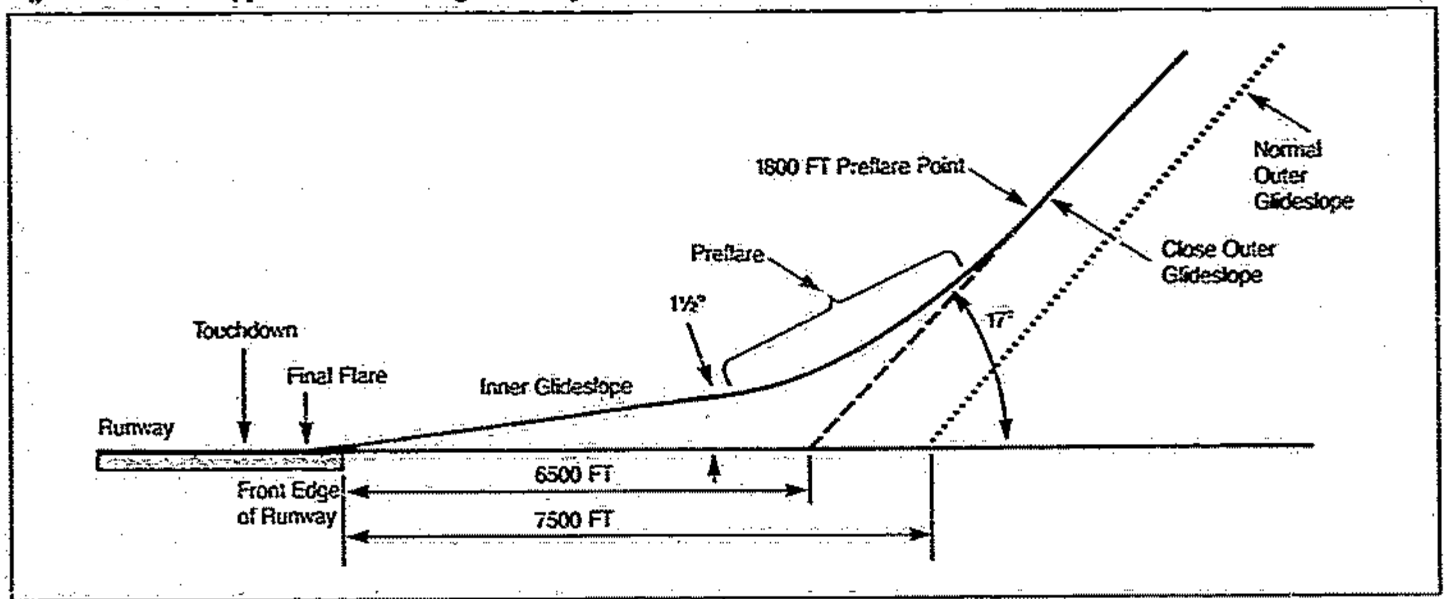


- Xenon lights are used for landing at night. NASA has these lights stored at the TAL sites but does not plan any night landings.
- Arresting barriers at the end of runways are used to stop the shuttle from overrunning the end of the runway. If the length of the runway is 12,500 feet or less, it is required to be equipped with an arresting barrier. An arresting barrier was installed at Moron, which has an 11,800-foot runway with a 1,000-foot overrun at each end, and at Zaragoza, which has a 12,196-foot runway with a 984-foot overrun at each end. An arresting barrier was also installed at Banjul, which has an 11,811-foot runway with a 400-foot overrun at one end and a 200-foot overrun at the other end. An arresting barrier was not installed at Ben Guerir because the 13,720-foot runway plus the 1,500-foot overrun is sufficient to accommodate shuttle landings without one.
- Precision Approach Path Indicator (PAPI) lights and their associated strobe lights would be used to align the space shuttle on an outer glideslope of 17 degrees—the angle at which the shuttle begins its approach to the runway. The strobes are used to attract the astronauts' attention to the PAPI lights. The PAPI lights consist of four light sets, each having a white upper beam and a lower red beam. If the pilot is flying a

17-degree glideslope, the pilot will see three red lights and one white light. PAPI lights are installed at 6,500 and 7,500 feet from the runway.

The 6,500-feet PAPI lights are used during high-wind conditions, and the 7,500-feet PAPI lights are used during low-wind conditions. Figure II.5 illustrates the basic landing approach and geometry, and figure II.6 shows a PAPI light. PAPI lights are installed before each launch, removed from their foundation pads after the launch, and stored until 1 or 2 days before the next scheduled launch. The PAPI lights were available at each of the TAL sites at the time of our visits, and we were told by NASA contractors at these sites that they had been tested and were operable.

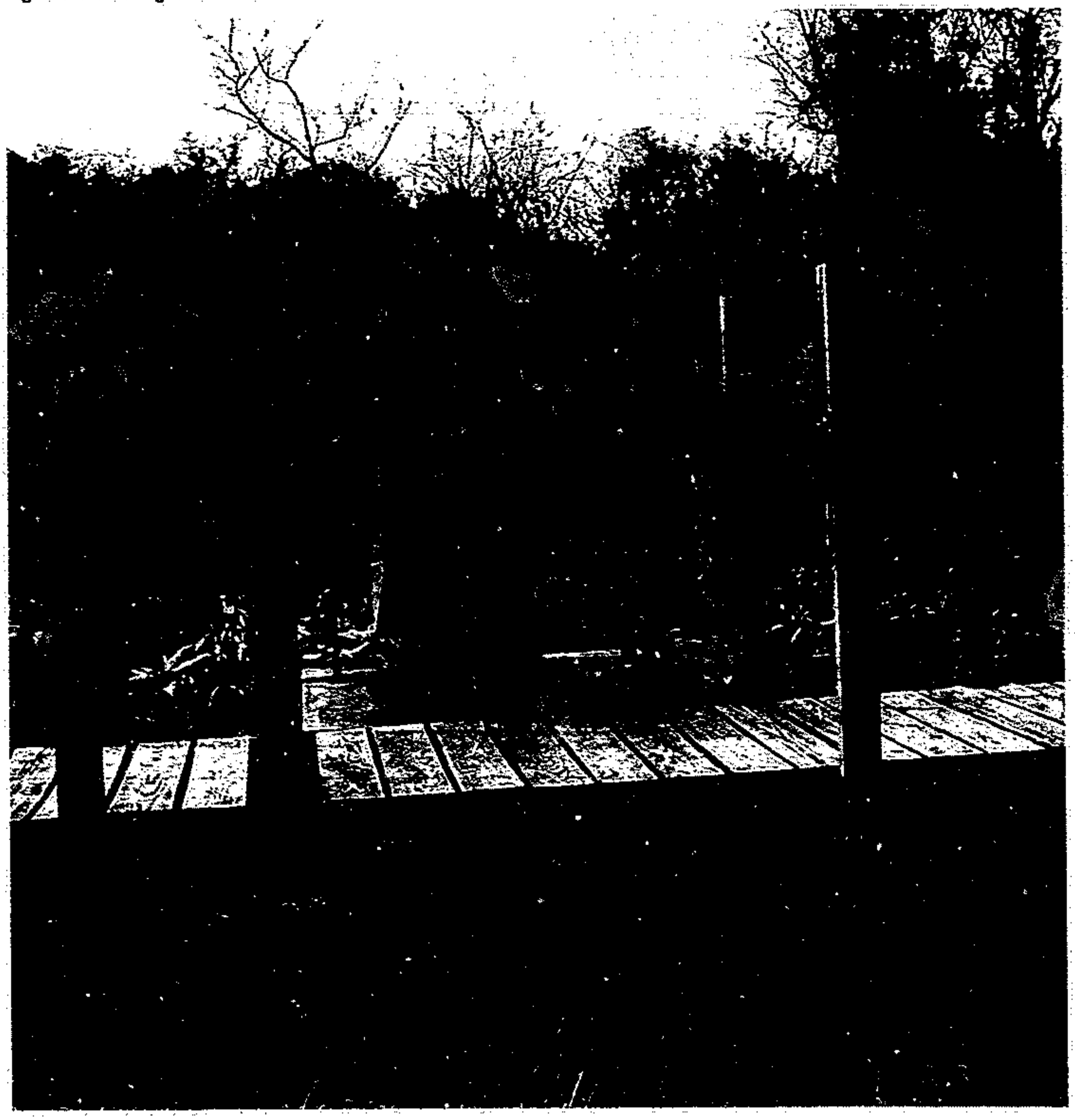
Figure II.5: Shuttle Approach and Landing Geometry



For a strong headwind landing, a second outer glideslope is provided, which intersects the ground at 6,500 feet from the front edge of the runway. The Mission Control Center determines which aim point to use based on winds and other factors.

Preflare and final flare refer to the raising of the shuttle's nose, which is a maneuver used in landing.

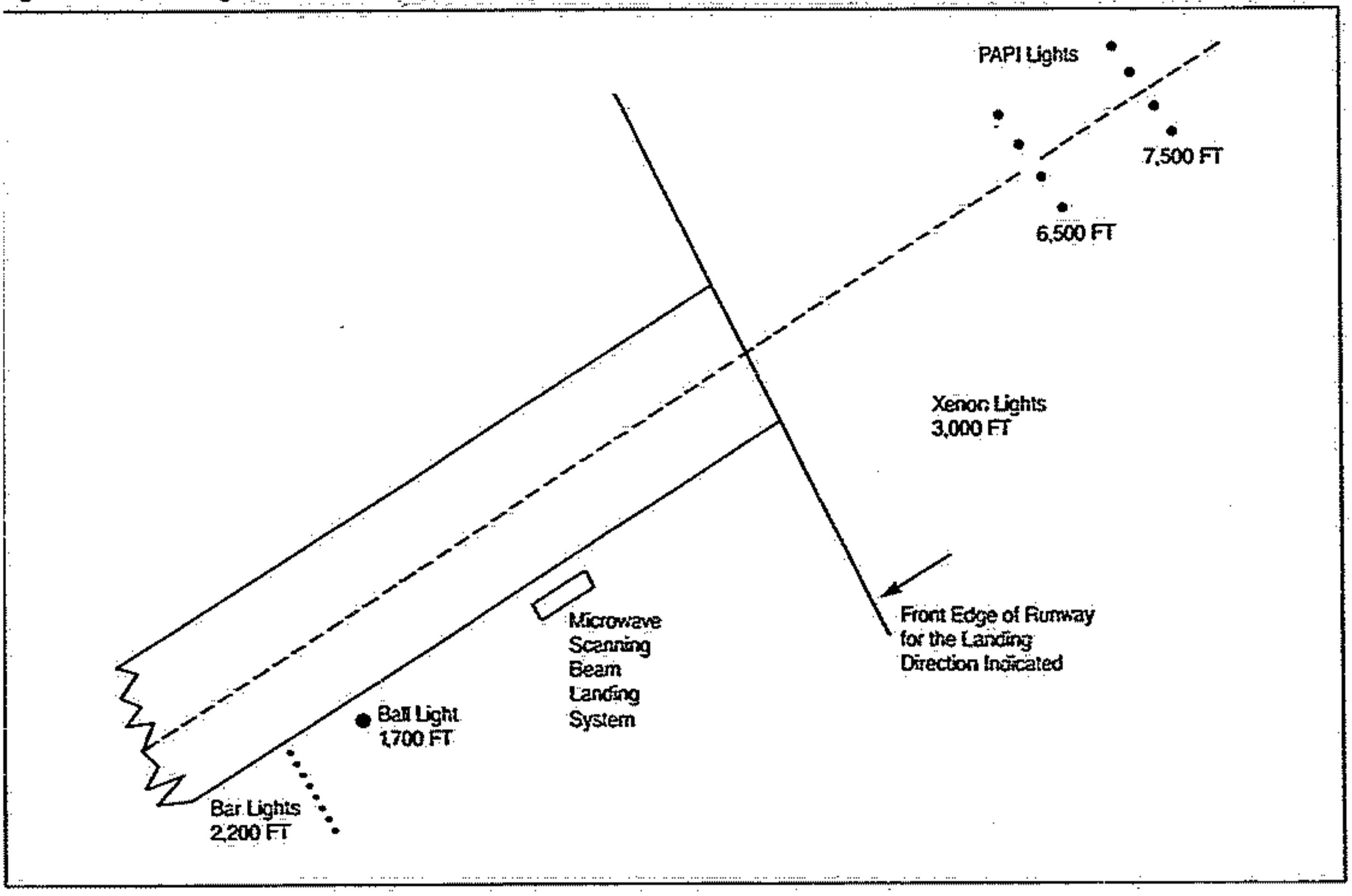
Figure II.6: PAPI Light Installed at KSC



Some PAPI lights are located outside the TAL sites' perimeters, and NASA had to negotiate with local farmers or government officials for the use of the land for these lights. In Ben Guerir, both ends of the runway can be used for landings; thus, two sets of PAPI lights are used. Both the 6,500- and 7,500-feet PAPI lights at one end of the runway are located on the base; however, the 7,500-feet PAPI lights at the other end are on private land. NASA and the local government in Ben Guerir had not reached an agreement for leasing this property at the time of our visit on May 30, 1988. However, government officials in Ben Guerir told NASA to proceed with construction of the foundation pads for the lights and that a lease price would be worked out. NASA officials subsequently agreed to a lease price. Construction of the PAPI lights foundation pads was completed after we left the Ben Guerir TAL site. PAPI lights pads at Moron Air Base are also located on private property, and a lease agreement between NASA and the owner has been reached. Guards are placed at both of the off-site PAPI locations on a 24-hour basis when the lights are installed. At Banjul, PAPI lights foundations were being constructed and were on schedule at the time of our visit. The installation of these foundations and the PAPI lights was completed in time to support the STS-26 mission.

Figure II.7 shows the location of some of the landing aids approaching the runway and on it.

Figure II.7: Positioning of Selected TAL Site Landing Aids



Communications Equipment

Communications equipment installed at each TAL site includes the International Maritime Satellite System for communications between the TAL sites, KSC, and Johnson Space Center and the UHF-A/G Radio System for communications between the TAL sites and the shuttle.

Site Support

Various groups of specialists are stationed at the TAL sites and other potential abort sites during shuttle launches; others will be sent to the site of any actual abort landing. These specialist groups include mission support teams and deployed operations teams. NASA officials told us that verification of the readiness of these teams was part of the Operational Readiness Inspections. The inspections found that these teams have been staffed, trained, and scheduled as to when and where they will be deployed.

The purpose of these groups is to provide, or support others in providing launch and recovery; security; crash, fire, and rescue; and other services.

The efforts of these groups are coordinated through the Landing and Recovery Director, who is located at KSC during launch, provides management oversight to all landing sites for prelaunch operations, and reports to the NASA Test Director[6] on the readiness of the landing sites to support a shuttle launch. The Landing and Recovery Director obtains prelaunch status reports from the Ground Operations Managers located at each landing site and updates the teams at the landing sites on the progress of the launch countdown.

Mission Support Teams

About 10 days before each scheduled launch, the mission support teams go to the TAL sites and other sites designated for participation as augmented landing sites[7] to set up and check out navigational equipment, landing aids, and communications equipment. After a launch, the teams deactivate the sites.

The mission support teams at each site are under the direction of a Ground Operations Manager. They supervise, assist, and advise local

[6]NASA's Test Director directs the KSC Test Team, which is composed of system engineers and test managers who are responsible for conducting operations from consoles in the Launch Control Center. The Test Director reports to the Launch Director.

[7]TAL sites and the end-of-mission landing sites comprise the augmented landing sites. They are equipped with shuttle-unique navigational and other equipment and landing aids.

operators and administrators. At Moron and Zaragoza, where direct DOD support is available, mission support teams consist of about 20 personnel provided by NASA. At Ben Guerir and Banjul, where no direct DOD support is available, the teams consist of about 30 to 33 people, as listed in table II.1.

Table II.1: Composition of Mission Support Teams at TAL Sites in Africa

Personnel position or area of activity[a]	Number of personnel: Ben Guerir	Number of personnel: Banjul
Ground Operations Manager (NASA)	1	1
Public Affairs Officer (NASA)	1	1
Orbiter Flight Operations (NASA)	1	1
Medical (NASA)	1	1
DOD Manager for Space Shuttle Support Representative	1	1
Operations Engineer (SPC)[b]	1	1
Quality (SPC)[c]	1	0
Senior Safety Advisor (NASA)	1	1
Senior Security Advisor (NASA)	1	1
Crash, Fire, and Rescue (EG&G)[d]	7	7
Tactical Air and Navigation System/ Microwave Scanning Beam Landing System (SPC)	3	3
Visual Landing Aids (SPC)	4	4
Communications Personnel (SPC)	2	2
Tow Team (SPC)	2	2
Payload Operations—DOD missions only (NASA)	2	2
Weather (NASA)	1	2
Subtotal	**30**	**30**
Xenon lights—night missions only (SPC)	3	3
Total	**33**	**33**

[a]The organization that each member of the team is from is indicated in parentheses.

[b]SPC is the abbreviation for Shuttle Processing Contractor.

[c]The listing from which this schedule was derived did not indicate a Quality staffer for Banjul; however, a NASA official told us that NASA plans to have a Quality staffer at all sites.

[d]EG&G is a NASA contractor for crash, fire, and rescue support.

Mission support team members helped to initially set up the TAL sites, and some team members were performing site activation activities during our visits to the TAL sites.

In addition to the Ground Operations Manager, the teams consist of supplemental crash, fire, and rescue; security; safety; and shuttle contractor personnel who would provide assistance and oversee the rescue of the

crew and the deservicing of the shuttle's toxic materials. At Ben Guerir, for example, the team provides training for local emergency support personnel and would help support the recovery of the space shuttle in the event of an emergency landing, which includes securing the shuttle and its payload and preparing them for their return to the United States.

Deployed Operations Teams

If the shuttle lands at one of the TAL sites, all equipment and personnel required to deservice it and its cargo and return it to KSC would be brought to the TAL site. The total number of people required to perform the necessary tasks may vary up to 450 during the estimated 45 to 60 days that would be required to service and remove the shuttle.

The first NASA team to arrive after the shuttle lands would be the rapid response team, composed of approximately 40 to 50 people from NASA, NASA contractors, and the DOD Manager for Space Transportation System Contingency Support Operations.[8] The rapid response team would arrive within 24 hours of a shuttle landing and would perform the initial postlanding operations, including deservicing the shuttle, controlling of operations, managing security and safety of the shuttle and its payload, and initiating mishap investigations and reports.

Turnaround team members would be time-phased to arrive at the TAL sites as needed to further deservice the shuttle, remove its engines,[9] and mate it with the shuttle airlift carrier. NASA estimates that the turnaround operations will involve approximately 90 U.S. Air Force airlift sorties and require 45 to 60 days to accomplish. In addition, some sealift would be needed. For instance, the crane needed to lift the shuttle for placement on top of the 747 carrier would have to be transported by sea because of its size and weight.

[8]The DOD Manager for Space Transportation System Contingency Support Operations serves as the working interface between DOD and NASA to receive, coordinate, and respond to NASA contingency operations support requirements within the capability of DOD support forces. In addition to providing medical and crash, fire, and rescue services, it can also arrange for the following types of services, if requested by NASA: recovery of astronauts, landing site support, payload security, news media support, solid rocket booster recovery support, communications associated with shuttle support operations, and coordination of airlift/sealift and salvage support.

[9]According to a NASA official, NASA would not remove the payload from the shuttle's cargo bay because the bay doors are designed to open only in space—a zero gravity environment. Therefore, the engines would be removed to lessen the weight of the shuttle so that it could be airlifted to KSC.

Security, Medical, and Crash, Fire, and Rescue Services

The ways in which security, medical support, and crash, fire, and rescue services are provided vary from one TAL site to the next. Security services, for example, are provided through DOD, the host country's military, or contractors. Similarly, crash, fire, and rescue services are provided through DOD or through a NASA contractor working with host country's emergency support personnel.

Security Support Services

Security support consists of protection for equipment at TAL sites and for the shuttle vehicles and its payload, local traffic and crowd control, and security in support of safety operations. There are different arrangements for providing security services at each TAL site.

The TAL sites in Spain are operating Spanish air bases where routine security is provided by the Spanish Air Force for all equipment and facilities on the bases, including TAL equipment. In the case of an abort to either Spanish TAL site, the Spanish Air Force would provide general security for the shuttle and its payload by securing the perimeter of the base. At Moron, the Spanish Air Force would also provide direct security of the shuttle and its payload and traffic and crowd control during the first 24 hours, or until U.S. military personnel arrive from Germany and other locations in Spain. At Zaragoza, U.S. Air Force personnel stationed at the base would provide direct shuttle security.

The security situation at the TAL sites in Africa is arranged somewhat differently. At Banjul and Ben Guerir, NASA is contracting for security services with both military and civilian entities. At Ben Guerir, the Royal Moroccan Air Force (RMAF) is the contractor. NASA's efforts in arranging for RMAF security services is described in appendix III. In a shuttle launch abort to Banjul, shuttle security would be provided by the Gambian National Police. Depending on the shuttle payload, additional U.S. security personnel may also be involved. A local civilian contractor provides routine security of TAL equipment at Banjul.

Security personnel were present at each TAL site at the time of our visits.

Medical Support and Crash, Fire, and Rescue Services

If the shuttle aborts to a TAL site, the landing may be normal and not require medical or crash, fire, and rescue assistance. However, NASA has arranged for such assistance.

These arrangements vary somewhat from one TAL site to another, depending on the unique needs of each. For example, Zaragoza is a large

operating Air Force base with a full complement of medical and crash, fire, and rescue personnel. Therefore, Zaragoza would be able to provide these services without requiring additional outside assistance. On the other hand, Moron is a relatively small Air Force base, maintaining only a small detachment of U.S. military personnel. Consequently, during shuttle launch operations, the DOD Manager for Space Transportation System Contingency Support Operations prepositions approximately 20 persons to provide crash, fire, and rescue, bio-environmental, and medical services. Spanish fire fighters are the primary providers of crash, fire, and rescue services at these Spanish TAL sites.

Similar medical and crash, fire, and rescue teams will be available at Banjul and Ben Guerir. At Banjul, the teams arrive 2 days before launch and consist of 21 medical personnel and a C-130 aircraft crew for search and rescue. At Ben Guerir, a 12-person DOD medical team is prepositioned on-site 24 hours before launch. At Ben Guerir and Banjul, a NASA contractor provides crash, fire, and rescue support and also trains local personnel. NASA contractor personnel would conduct actual rescue operations, whereas local fire fighters would operate the fire fighting vehicles. At Ben Guerir, training and fire fighting equipment[10] have been provided to the RMAF's crash, fire, and rescue personnel. The training was conducted during site activation and occurred again when the mission support team deployed to support the STS-26 launch. At Banjul, the NASA contractor would provide crash, fire, and rescue services with support from Gambian crash, fire, and rescue personnel assigned to the airport. According to a NASA official, the airport has two fire engines, which are used for normal air traffic. One of these fire engines was recently shipped to London for repair, leaving only one available for a possible contingency landing of the STS-26 shuttle. We have since been informed by NASA officials that this fire engine was repaired and returned to The Gambia. According to a NASA official, a minimum of three fire trucks are required for each TAL site; however, NASA has approved using only two fire trucks at Banjul. NASA officials also indicated that the Gambian government will try to obtain funds from the African Development Agency for a third vehicle.

[10]NASA provided five fire fighting vehicles for Ben Guerir. These vehicles are to be used exclusively for NASA operations and are stored at a Moroccan air base in Marrakech. They are relocated to Ben Guerir during a launch.

Pending Issues

While assessing TAL site readiness, we identified two issues that may affect future operations at Ben Guerir, namely, the uncertainty about future NASA representation and the unknown cost of security services.

Uncertainty About Future NASA Representation

NASA is generally represented at its TAL sites by other organizations. NASA's shuttle-related activities in Spain are facilitated by the DOD Manager for Space Transportation System Contingency Support Operations, who provides logistic support by

- coordinating security and crash, fire, and rescue services and medical support;
- training support services personnel;
- arranging and participating in simulations and Operational Readiness Inspections; and
- coordinating and/or managing other support activities as required.

At Banjul, NASA uses U.S. Embassy personnel to provide some support services similar to the DOD Manager for Space Transportation System Contingency Support Operations. In addition, NASA has hired a retired State Department employee to serve as a NASA liaison to the U.S. Embassy and the Gambian government. His duties include verifying the status of NASA-owned vehicles, including maintenance and fuel; overseeing security guards to ensure adequate contractor performance; making hotel and travel arrangements for NASA personnel; coordinating shipping and custom clearances for equipment supplies; and assisting NASA personnel through immigrations/customs.

In Morocco NASA relies on the Moroccan U.S. Liaison Office[11] to

- notify the RMAF of NASA visits,
- coordinate visits,
- make hotel and flight reservations and provide other travel-related services,
- administer the weather support agreement,
- oversee security arrangements, and
- clear equipment and supplies through customs.

[11] The Moroccan U.S. Liaison Office is an office attached to the U.S. Embassy and staffed with U.S. military personnel. It serves as the single U.S. point of contact with the Moroccan government for all U.S. construction-related activities in Morocco.

Officials at the Moroccan U.S. Liaison Office believe that these services should be provided through a NASA contractor or employee and that too much of their time is spent on these activities, which are not part of their primary responsibility for overseeing construction activities. If this office reduces its support to NASA in the future or is unable to keep up with rising demand as shuttle flights become more frequent, NASA would have to make alternate representational arrangements. NASA officials told us that they are looking into the possibility of having a NASA-supported person stationed at the U.S. Embassy to administer NASA's affairs locally.

Unknown Cost of Security

The RMAF and NASA have not agreed to the cost of security services at Ben Guerir or to the number of personnel required to perform these services. The RMAF offered to provide NASA with a security force of 160 soldiers and requested that NASA construct a barrack and other support facilities to house them. However, NASA believes that only seven or eight security personnel will be required for routine security of equipment and facilities. Because of this disparity, NASA suggested contracting with a civilian firm to provide security. The RMAF rejected this proposal, stating that Ben Guerir is a military facility and that no private civilian firm would be permitted on the base. According to NASA officials, the Moroccan government has been informed that NASA does not have the money or the authorization to build barracks. In response to the NASA proposal for a civilian contractor, the RMAF told NASA that it would provide site security, and the price for its services could be determined later. If the RMAF view prevails—permanent facilities and 160 personnel—NASA would have to fund significantly higher security costs in the future.

A similar problem exists with respect to the use of Moroccan security personnel for guarding the shuttle if it should land at Ben Guerir. NASA estimates that approximately 25 Moroccan personnel would be required to guard the shuttle's perimeter (access to it would be controlled by U.S. personnel). According to NASA officials, the RMAF is willing to provide the security force but wants NASA to pay for it.

A NASA official told us that NASA negotiated an interim agreement with the Moroccans that provided 33 Moroccan security personnel, supplemented by NASA personnel, to cover the STS-26 launch. The Moroccan government accepted NASA's proposal, but provided approximately 135 additional security personnel for the STS-26 mission. NASA anticipates that the Moroccan government will require it to fund only the 33 security personnel agreed upon in the negotiations. NASA renewed its efforts

to negotiate a long term agreement for future shuttle launches in early November 1988, and the cost of the Moroccan security personnel provided for the STS-26 mission is part of these negotiations.

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